IS 7906-5 (2004): Helical Compression Springs, Part 5: Hot Coiled Springs Made from Circular Section Bars [TED 21: Spring]

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भारतीय मानक

कुंडलिनी संपीडन कमानियां

भाग 5 वृताकार काट सरियों से बनी तप्त कुंडलिनी कमानियां — विशिष्टि

(दूसरा पुनरीक्षण)

Indian Standard

HELICAL COMPRESSION SPRINGS

PART 5 HOT COILED SPRINGS MADE FROM CIRCULAR SECTION BARS — SPECIFICATION

(Second Revision)

ICS 21.160

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

September 2004 **Price Group 4**

FOREWORD

This Indian Standard (Part 5) (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Automotive Springs and Suspension Sectional Committee had been approved by the Transport Engineering Division Council.

This standard was originally published in 1979 and revised in 1989. The second revision of the standard was undertaken as a result of further experience gained in the manufacture and use of the components and other developments in the field.

The following technical changes have been incorporated:

a) Permissible deviations on nominal diameter of rods with a rolled surface and machined surface.

b) Permissible deviations of spring force.

c) Revision of reference standards which are necessary adjuncts to this standard.

d) Addition of IS 13190 : 1991 'Recommended practice for eddy current examination by rotating probe method of round steel bars' which was under preparation earlier.

This standard is one of the series of standards on helical coiled compression springs. The other parts in this series are as follows:

(Part 1) : 1997	Design and calculations for springs made from circular section wire and bar
(Part 2) : 1997	Specification for cold coiled springs made from circular section wire and bar
(Part 3) : 1997	Data sheet for springs made from circular section wire and bar
(Part 4) : 1987	Selection of standard cold coiled springs made from circular section wire and bar
(Part 6) : 1978	Design and calculations for springs made from rectangular section bar steel
(Part 7) : 1989	Quality requirements for cylindrical coil compression springs, used mainly as vehicle suspension springs
(Part 8) : 1989	Method of inspection of hot coiled compression springs made from circular section bars

In the preparation of this standard, assistance has been derived form DIN 2096 Part 1-1991 'Helical compression springs made of round wire and rod; Quality requirements for hot formed compression springs', issued by the Deutsches Institut für Normung (DIN).

The composition of the Committee responsible for the formulation of this standard is given at Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

HELICAL COMPRESSION SPRINGS

PART 5 HOT COILED SPRINGS MADE FROM CIRCULAR SECTION BARS — SPECIFICATION

(Second Revision)

1 SCOPE

1.1 This standard (Part 5) covers hot coiled cylindrical compression springs made from round bar steel which are hardened and tempered after coiling.

1.2 This standard is applicable to springs having the following parameters:

a) Bar diameter, d from 8 to 60 mm,
b) Outside diameter, D_e < 460 mm,
c) Unloaded length, L_0 < 800 mm,
d) Number of active coils, n < 3, and
e) Coil ratio, w from 3 to 12.

1.3 In case the lot size exceeds 5 000, then the dimensional tolerances as given in IS 7906 (Part 7) shall be applicable.

2 REFERENCES

The following standards contain provisions which through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
1500 : 1983	Method for Brinell hardness test for metallic materials (*second revision*)
2500	Sampling inspection procedures
(Part 1) : 2000	Attribute sampling plans indexed by acceptable quality level (AQL) for lot-by-lot inspection (*third revision*)
(Part 2) : 1965	Inspection by variables for percent defective
3195 : 1992	Steel for manufacture of volute and helical springs (for railway rolling stock) (*third revision*)
3431 : 1982	Steel for the manufacture of volute, helical and laminated springs for automotive suspension (*second revision*)
3703 : 1980	Code of practice for magnetic particle flaw detection (*first revision*)
7001 : 1989	Shot peening of steel parts — Specification (*first revision*)
7906	Helical compression springs:
(Part 1) : 1997	Design and calculations for springs made from circular section wire and bar (*first revision*)
(Part 3) : 1975	Data sheet for springs made from circular section wire and bar
(Part 7) : 1989	Quality requirements for cylindrical coil compression springs used mainly as vehicle suspension springs
13190 : 1991	Recommended practice for eddy current examination by rotating probe method of round steel bars

3 TERMINOLOGY

The following symbols and units shall apply (*see also* Fig. 1):

Symbol	*Term*	*Unit*
A_D	Permissible deviation of the mean coil diameter, D, of the unloaded spring	mm
A_d	Permissible deviation of the nominal diameter, d	mm
A_{De}	Permissible deviation of the external coil diameter, D_e, of the unloaded spring	mm
A_{Di}	Permissible deviation of the internal coil diameter, D_i, of the unloaded spring	mm
AF	Permissible deviation of the spring force, F, at a specified spring length, L	N
A_{Lo}	Permissible deviation of the Length, L_0, of the unloaded spring	mm
Ant	Permissible deviation of the total number, nt,of turns	—

Symbol	Term	Unit
A_R	Permissible deviation of the spring rate, R	N/mm
$D = \frac{D_e + D_i}{2}$	Mean coil diameter	mm
D_e	External coil diameter	mm
D_i	Internal coil diameter	mm
d	Wire or rod diameter prior to the coiling of the spring	mm
d_{Max}	Upper deviation of nominal diameter	mm
e_1	Permissible deviation of generatix from the vertical, measured on the unloaded spring (*see* Fig. 1)	mm
e_2	Permissible deviation from absolute parallelism of two ground spring ends of the unloaded spring, measured at the external diameter, D_e	mm
F_1 to F_n	Spring forces, correlated to the spring length, L_1 to L_n	N
F_p	Spring force, correlated to the test length, L_p	N
$F_{c\,theo}$	Theoretical spring force, correlated to the solid length, L_c	N
L_0	Length of the unloaded spring	mm
L_1 to L_n	Lengths of the loaded spring, correlated to the spring forces, F_1 to F_n	mm
L_c	Solid length, shortest possible spring length (all the coils in contact with one another)	mm
$L_n = L_c + S_a$	Shortest permissible test length	mm
L_p	Length of loaded spring, correlated to the test force, F_p	mm
L_s	Length of spring during presetting	mm
n	Number of active turns	—
n_t	Total number of turns	—
$R = \frac{\Delta F}{\Delta S}$	Spring rate	N/mm
s_1 to s_n	Spring deflections, correlated to the spring forces, F_1 to F_n	mm
$s_c = L_0 - L_c$	Solid spring deflection, correlated to the theoretical spring force, $F_{c\,theo}$	mm
$S_a = L_n - L_c$	Safety gap, sum of the minimum clear distance between adjoining active turns at the spring length, L_n	mm
S_p	Spring deflection, correlated to test force, F_p	mm
$w = \frac{D}{d}$	Coiling ratio	—

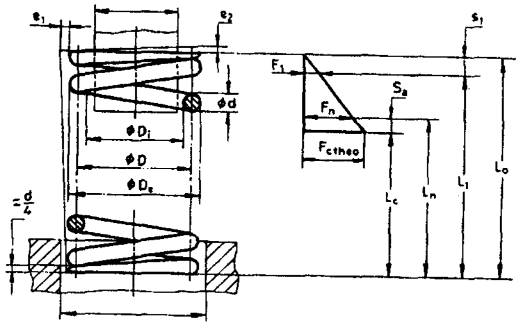

FIG. 1 COMPRESSION SPRING WITH ENDS CLOSED AND GROUND WITH THEORETICAL CHARACTERISTIC LINE

4 DESIGN

4.1 Material

The steel of different grades as given in IS 3195 and IS 3431 shall be used as the starting material for springs. Any other material of special composition for special applications may be used in accordance with the requirements of the user.

4.2 Direction of Coiling

Helical compression springs have a right-handed (clockwise) winding as a general rule. Springs for application in nested sets (assemblies) or where one spring is working inside the other, the direction of coiling is alternatively left and right. The outer springs are generally with right-hand coiling. If the springs are required to have a left-hand (anticlockwise) coiling, the same must be mentioned in the order and enquiry or appropriately in data sheet as given in IS 7906 (Part 3).

4.3 Spring Ends

For transmitting axial loads on the connecting body, the spring ends shall be so formed that for any position of the spring, the spring action is axial as far as possible. This is generally achieved by decreasing the pitch at the runout coil. The spring end is then ground so that a flat seating surface is obtained. Other types of spring ends are shown in Fig. 2 to Fig. 5.

4.4 Total Number of Coils, n_t

The total number of coils (n_t) varies depending on the end construction of the spring. For different construction the number of coils is given below:

Types of Ends According to	*Total Number of Coils, n_t*
Fig. 1 and Fig. 2	$n + 1.50$
Fig. 3	$n + 1.00$
Fig. 4	$n + 1.50$
Fig. 5	$n + 1.67$

4.5 Detailed design calculations for springs are covered by IS 7906 (Part 1).

5 WIRE OR ROD DIAMETER BEFORE COILING

5.1 Roads with Rolled Surface (*see* Table 1)

Table 1 Nominal Diameter and Permissible Deviations

Sl No.	Nominal Diameter d	Permissible Deviations A_d
(1)	(2)	(3)
i)	$8 < d < 11.5$	± 0.15
ii)	$12 < d < 21.5$	± 0.2
iii)	$22 < d < 29.5$	± 0.25
iv)	$30 < d < 39$	± 0.3
v)	$40 < d < 50$	± 0.4
vi)	$52 < d < 60$	± 0.5

5.2 Roads with Machined Surface, that is with Turned, Peeled or Ground Surface (*see* Table 2)

Table 2 Permissible Deviations of the Nominal Diameter

Sl No.	Nominal Diameter d	Permissible Deviations A_d
(1)	(2)	(3)
i)	$8 < d < 10$	± 0.05
ii)	$10 < d < 20$	± 0.08
iii)	$20 < d < 30$	± 0.10
iv)	$30 < d < 40$	± 0.12
v)	$40 < d$	± 0.15

6 MANUFACTURING

6.1 Preparation of Bars

6.1.1 Springs for non-critical application can be manufactured from as rolled bars.

6.1.2 Springs for critical applications, or where specific fatigue life is to be met, or where load-rate characteristics are important are generally made from centreless ground bars. In case the springs are to be manufactured from centreless ground bars, the same must be mentioned in the order and enquiry or appropriately in data sheet as given in IS 7906 (Part 3).

6.1.2.1 If specified in the drawing/data sheet/ purchase order, all ground bars should be subjected to crack detection, by any one of the following methods:

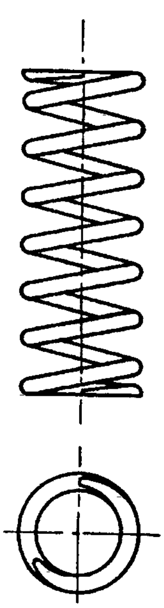

FIG. 2 ENDS CLOSED AND GROUND

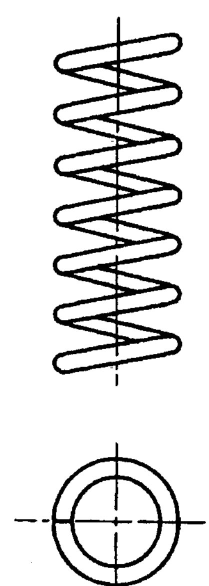

FIG. 3 ENDS OPEN AND UNGROUND

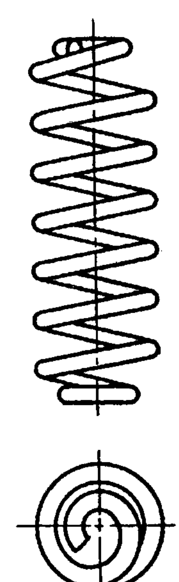

FIG. 4 PIGTAIL ENDS

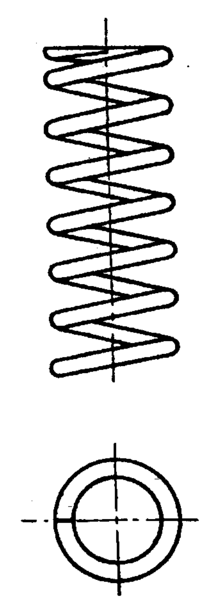

FIG. 5 ONE END FORGED AND GROUND AND ONE END OPEN

a) Magnetic particle method as given as IS 3703; or
b) Eddy current method as given in IS 13190.

6.1.3 Before coiling, both ends of the bars should be properly tapered (if specified in the spring drawing) to give the finished spring a firm bearing. The taper length should be approximately equal to 0.75 of the mean circumference of the spring. The taper portion should be smoothly tapered with the tips rounded off and tip thickness at the edge should be approximately 1/4 of the bar diameter.

6.2 Coiling and Heat Treatment

The bars for coiling should be uniformly heated in an indirectly heated furnace and soaked sufficiently. The heated bars should be immediately coiled and pitched, taking care to ensure that the red hot material remains in contact with air for minimum possible time so as to avoid oxidation. The springs shall be uniformly heat treated for developing the required physical properties of materials and shall have the following final hardness:

Material	*Hardness*
Carbon steels	360 to 420 HB
Silica-manganese steels	380 to 460 HB
Chrome-alloy steels	400 to 460 HB

NOTES
1 The hardness should be measured only on inactive coils.
2 The hardness of the spring shall be measured on the outside surface after removal of the decarburized layer.

6.2.1 For springs made from unground bars, the limit for decarburization may be fixed by agreement between the purchaser and the supplier.

6.2.2 Hardness checking shall be done in accordance with IS 1500.

6.2.3 For springs made from centreless ground bars, the total depth of decarburization shall not exceed 1 percent of the bar diameter.

6.3 Scragging

Each and every spring should be scragged 3 times in quick succession. The scragging height should be as indicated in the spring drawing/data sheet. In case there is no such indication the springs should be scragged home. The scragging load in such cases should not exceed 1.5 times the theoretical axial load corresponding to the block length.

6.4 End Grinding

Springs having ends as shown in Fig. 1 and Fig. 2. Springs should be ground to ensure square seating of the spring. The ends should not have any sharp edges or burrs. Unless otherwise specified, the tip shall not protrude beyond the outside diameter by more than 20 percent of the bar diameter.

6.5 Shot Peening

For increasing the fatigue life, the springs shall be shot peened. After shot peening, the Almen arc height shall conform to those given in IS 7001 with a minimum arc height of 0.4 mm.

6.6 Surface Protection

The springs may be covered with suitable protective coating, immediately after shot peening to protect against corrosion. The protective coating to be applied/anti-corrosive treatment to be given to the springs, is subject to agreement between the purchaser and the manufacturer, and should be specified in the purchase order/drawing/data sheet.

6.7 Crack Detection

6.7.1 This is not applicable for springs made from rolled bars.

6.7.2 If specified in the purchase order/data sheet/drawing, springs made from ground bars should be subjected to magnetic crack detection, the percentage of springs to be checked and the acceptance criteria should be mutually agreed to between the purchaser and the supplier. This crack detection must be immediately carried out after shot peening.

7 TOLERANCES

For reasons of economy in production, tolerances could be prescribed only for those parameters which are necessiated by the particular application. If closer tolerances than those specified here are required, these shall be agreed to between the manufacturer and the purchaser.

7.1 Tolerances on Bar Diameter, A_d

7.1.1 Tolerance on bar diameter *d*, before coiling, both for rolled bars and ground bars shall be according in to IS 3195 or IS 3431 as applicable.

7.1.2 After coiling/heat treatment the tolerance on finished bar diameter for springs made from centreless ground bars, shall be ± 0.5 percent of the bar diameter or ± 0.25 mm, whichever is higher.

7.2 Tolerance, A_D on Coil Diameter D, D_e, D_i for Unloaded Springs

Tolerance shall be as given in Table 1. Only one diameter shall be indicated for tolerance in the order or enquiry [*see also* IS 7906 (Part 3)] as follows:

a) D_e, when the spring is working in a guide, and
b) D_i, when the spring is working over a guide (arbor).

The numerical values of the permissible deviations in Table 3 below apply solely to the end turn.

Because the active turns of the spring exhibit wider tolerances than those specified in Table 1 for the end turns, it is recommended, in the case of springs which operate inside a sleeve or over a mandrel, to specify in addition either the minimum diameter of the sleeve and the maximum diameter of the mandrel, respectively, on drawings and in enquiry/data sheet/ purchase order.

7.3 Permissible Deviation of A_{nt}, Total Number of Turns

This requirement is applicable in cases where total number of coils is not a means of manufacturing compensation.

7.3.1 The following relationship is applicable to springs made from as rolled bars:

$$A_{nt} = \pm 0.015\, n_t$$

7.3.2 The following relationship is applicable to springs made from centreless ground bars:

$$A_{nt} = \pm 0.012\, n_t$$

7.4 Tolerances on Squareness and Parallelism for Springs with Ground Ends Made from as Rolled or Ground Steel Bars

These shall be as given in Table 4.

7.5 Tolerance, A_{Lo} on Unloaded Length, L_o of the Spring

In the case of springs with stipulated axial loads and their associated spring height, the length L_o of the unloaded spring must in principle be regarded only as a guideline value. However, in cases where the length L_o is toleranced, the following formulae apply to the permissible deviation:

a) In case of springs made from as rolled bars:

$$A_{Lo} = \pm 0.015 \left[(L_o + s_c)\frac{2}{n} + 1 \right]$$

b) In case of springs made from ground bars:

$$A_{Lo} = \pm 0.012 \left[(L_o + s_c)\frac{2}{n} + 1 \right]$$

In the above cases, only the spring rate R may be specified additionally.

7.6 Tolerance on Spring Rate, A_R

The spring rate shall be toleranced only if it has a decisive influence on functional behaviour of the spring. In such cases, only one additional spring force, F, shall be toleranced in addition to the tolerance on the spring rate, R.

The tolerance shall be as follows:

For spring made from as rolled bars

$$A_R = \pm 0.065 \left(\frac{2}{n} + 1 \right) \times R$$

Table 3 Tolerances on Coil Diameter for Unloaded Springs

(*Clause* 7.2)

Sl No.	D_e or D_i		AD_e or AD_i			
			Springs Made of Rods with a Rolled Surface, for a Coiling Ratio, w		Springs Made of Rods with a Machined Surface for a Coiling Ratio, w	
	Over	Up to	Up to 8	Over 8	Up to 8	Over 8
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)		50	± 0.8	± 1.2	± 0.6	± 0.8
ii)	50	65	± 1	± 1.5	± 0.7	± 1
iii)	65	80	± 1.2	± 1.8	± 0.8	± 1.2
iv)	80	100	± 1.5	± 2.3	± 1	± 1.5
v)	100	125	± 1.7	± 2.6	± 1.1	± 1.7
vi)	125	160	± 2	± 3	± 1.3	± 2
vii)	160	200	± 2.2	± 3.3	± 1.5	± 2.2
viii	200	250	± 2.6	± 3.9	± 1.8	± 2.6
ix)	250	300	± 3.1	± 4.6	± 2.1	± 3.1
x)	300	460	± 4	± 5.5	± 2.5	± 4

Table 4 Tolerance on Squareness and Parallelism

(*Clause* 7.4)

Sl No.	Feature	Springs with Forged or Rolled Flattened Ends	Springs with Ground Ends
(1)	(2)	(3)	(4)
i)	Deviation in squareness, e_1	0.03 L_0 (corresponds to 1.7°)	0.01 L_0 (0.57°)
ii)	Deviation in parallelism, e_2	0.025 D_e (corresponds to 1.5°)	0.015 D_e (0.9°)

For spring made from ground bars:

$$A_R = \pm\ 0.045\left(\frac{2}{n}+1\right)\times R$$

7.7 Block Length, L_c of Spring (Solid Length)

The length of the completely compressed spring is dependent on the type of its ends as given below:

Types of Ends According to Figures	*Block Length*
a) Fig. 1 and Fig. 2	
1) Springs made from as rolled bars	$L_c < (n_t - 0.3)\ d_{Max}$
2) Springs made from ground bars	$L_c < (n_t - 0.4) d_{Max}$
b) Fig. 3	$L_c < (n_t + 1)\ d_{Max}$
c) Fig. 4	$L_c < (n_t - 1.15)\ d_{Max}$
d) Fig. 5	$L_c < 1.01\ n_t d_{Max} + t$

The actual (existing) total number of turns, rounded to one decimal place after the decimal point must enter in the equation for n_t.

NOTE — The solid height of the spring may not be specified as a rule on the spring drawing. In case the solid height is specially required depending on the spring application only then it is to be specified as a maximum value. In normal case the solid height is not to be checked.

7.8 Permissible Deviation of the Spring Force

The relationship below applies to springs made of rods with a rolled surface:

$$A_F = \pm 0.015\left[(L_o + s_p\left(\frac{2}{n}+1\right).R\right]$$

The following relationship applies to springs made of rods with a machined surface:

$$A_F = \pm 0.012\left[(L_o + s_p\left(\frac{2}{n}+1\right).R\right]$$

In special cases, the tolerance zone of the spring force for springs which operate together in pairs or groups can be sub divided into test groups.

7.9 Minimum Space Between Individual Working Coils Under Maximum Permissible Test Load

The sum of the minimum spaces between the individual working coils at L_n is given by:

$$S_a \geq 0.02\ D_e\ .\ n$$

That is the clear distance between adjoining turns per turn $\left(\frac{S_a}{n}\right)$ shall be greater than or equal to 2 percent of the external coil diameter, D_e.

Within S_a, the spring characteristics can be strongly progressive.

7.10 Workmanship

The surface of springs shall be free from injurious defects within normal limitations of hot coiled springs.

7.11 Bow

Bow shall be half the permitted tolerance of the out-of-squareness and the maximum shall occur in the middle one-third of the spring.

7.12 Uniformity of Pitch

The pitch of the coils shall be sufficiently uniform so that when the spring is compressed to a height representing a deflection of 85 percent of nominal total travel, none of the coils shall be in contact with one another, excluding the inactive end coil. Under 85 percent deflection the maximum spacing between any two adjacent active coils shall not exceed 40 percent of the nominal free coil spacing.

8 COMPLEMENTARY ADJUSTMENT FOR MANUFACTURING

To enable springs to be held within limits of axial loads, the manufacturer requires complementary adjustments during production. These shall be specified by the following methods:

Prescribed Parameters (1)	*Manufacturer's Discretion for* (2)
One axial load and the corresponding load length are specified	L_o
One axial load with corresponding load length and the spring rate	L_o, d, n
One axial load with corresponding load length and unloaded length	n and d or n and D_e, D_i, D
Two axial loads and corresponding load lengths	L_o, n,d or L_o, n and D_e, D_i D
Length of the unloaded spring and the spring rate	d, n

9 SAMPLING

Sampling shall be done in accordance with IS 2500 (Part 1) and IS 2500 (Part 2).

10 TEST

10.1 Static Load Testing

The percentage of springs to be subjected to this test must be specified in purchase order/data sheet.

This testing is carried out on the spring in the normal direction of loading with the spring standing vertically. In each case, before carrying out the static test, the spring shall be compressed three times in quick succession to the block length or to a length

corresponding to the maximum permissible static stress value, whichever is more. If then it is scragged further, there shall be no further change in height. It is recommended to gradually approach the prescribed load length and read off the corresponding axial load. An instrument error of ±1 percent in the load indication shall be allowed.

10.1.1 Springs which are liable to buckle shall be tested over or in a guide. The method of testing shall be as agreed to between the purchaser and the manufacturer.

10.2 Characteristic Curve

The theoretical characteristic curve force deflection diagram (*see* Fig. 6) of a cylindrical helical compression spring, calculated according to IS 7906 (Part 1), is a straight line. In practice, however, the start and finish of the spring characteristics show a departure from linearity. If it is intended to check the spring rate by finding the characteristic of the spring, this shall be carried out over the range 0.3 to 0.7 F_n so as to cover the linearity with certainty. F_n here corresponds to the minimum permissible test length L_n. The spring rate is given by:

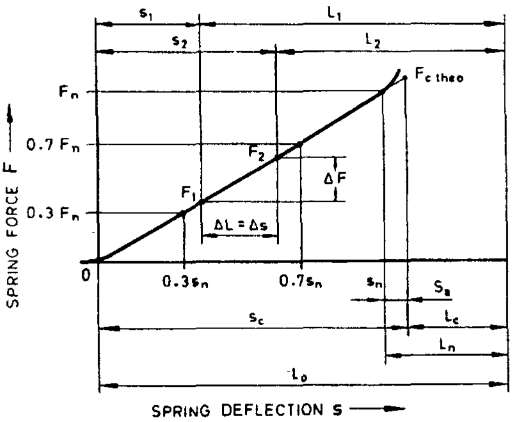

FIG. 6 SPRING CHARACTERISTIC CURVE

$$R = \frac{F_2 - F_1}{L_1 - L_2} = \frac{F_2 - F_1}{s_2 - s_1} = \frac{\Delta F}{\Delta L} = \frac{\Delta F}{\Delta S}$$

where ΔF is the force increment due to the length reduction or to the deflection increment.

10.3 Test Load for Compressing to Block Length

When compressing to block length, L_c for test purposes, the maximum spring force load to be applied would be 1.5 times the theoretical axial load spring force corresponding to block length, L_c.

10.4 Springs subjected to alternating loads shall be fatigue tested when manufactured from centreless ground bars subject to agreement between the purchaser and the manufacturer.

10.5 Special tests, such as, tests for endurance, cramp and temperature relaxation are subject to agreement between the purchaser and the manufactrer.

11 MARKING

11.1 The following markings shall appear appropriately on the spring:

a) Manufacturer's name or trade-mark, and
b) Year of manufacture.

These markings shall be stamped on springs made with wire diameters of 15 mm and above and shall be so applied that they are not detrimental to the life and the functioning of the springs.

11.2 BIS Certification Marking

The product may also be marked with the Standard Mark.

11.2.1 The use of Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

ANNEX A

(Foreword)

COMMITTEE COMPOSITION

Automotive Springs and Suspension Sectional Committee, TED 21

Organization	*Representative (s)*
Tata Motors Ltd, Jamshedpur	SHRI A. G. PRADHAN (***Chairman***) SHRI K. GOPALAKRISHNA (*Alternate*)
Akal Springs Pvt Ltd, Ludhiana	GENERAL MANAGER
All India Springs Manufacurers Association, Mumbai	SHRI A. A. MIRCHANDANI
Ashok Leyland Ltd, Chennai	SHRI APPALARAJU SHRI U. JAIKRISHNA (*Alternate*)
Association of State Road Transport Undertakings, New Delhi	SHRI A. S. LAKRA SHRI P. M. PHATE (*Alternate*)
Central Institute of Road Transport, Pune	SHRI N. R. KACHARE SHRI P. S. MUNOLI (*Alternate*)
Central Mechanical Engineering Research Institute, Durgapur	DR J. BASU DR T. K. PAUL (*Alternate*)
Conventry Springs & Engineering Co Pvt Ltd, Kolkata	SHRI A. BAFNA SHRI A. S. KOHLI (*Alternate*)
Controllerate of Quality Assurance (CQA) (OFV) Vehicle Factory, Jabalpur	GENERAL MANAGER
Gabriel India Ltd, Mumbai	SHRI K. SUNDARARAMAN SHRI S. K. BHAUMICK (*Alternate*)
Jai Parabolic Springs Ltd, Chandigarh	SHRI SUNIL HAROLIYA
Jamna Auto Industries Ltd, Yamuna Nagar	SHRI D. S. GILL SHRI B. K. KHANDELWAL (*Alternate*)
Kemen Springs Pvt Ltd, Mumbai	SHRI P. K. MIRCHANDANI
Mack Springs Pvt Ltd, Thane	SHRI D. V. SHARMA
Mahindra & Mahindra Ltd, Nashik	SHRI RAVINDRA DESHMUKH SHRI KAILASH JAT (*Alternate*)
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